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HAMMAR'S ECTOPLASMIC LAYER.

By E. A. Andrews.

Twenty years ago Selenka observed and figured a connection between the outer parts of the cells in cleaving eggs of several Echinoderms, but it remained for Professor Hammar to point out, in 1895,[1] the great significance of this intercellular structure.

In the sea urchin, *Echinus miliaris,* he found a thin outer coat that did not take part in cleavage, but remained as a continuous envelope over all the cells. This he interpreted as an ectoplasmic part of the egg, as a living connection between the cells, and as such of greatest import in understanding the interactions of cells in cleavage and in throwing light upon the divergent results of recent experimental work upon cleaving eggs. This, he thought, might be that organic intercellular connection potulated as probable by Whitman, Wilson and others.

Proof, however, of the living nature of this layer seems wanting; the figures of preserved sections raise a question as to how far the result may be due to or affected by the reagent used; and that the layer has a structure somewhat like an alveolar layer of Bütschli indicates, but does not prove, that the layer was actually living substance.

Later, E. B. Wilson[2] stated that he had, in the main, verified Hammar's results upon sea urchin eggs, presumably upon preserved material also.

The same objection may be raised against accepting all the results subsequently obtained by Hammar,[3] for though he found the outer ends of the cleaving cells of the eggs in Cœlenterates, Annelids, Molluscs, Arthropods and Tunicates connected by a thin line of substance, and though a similar connection is shown in the epithelium of young vertebrate embryos, yet the nature of the methods employed, the use of corrosive sublimate solution to shrink the cells apart save at the outer surface, raises grave suspicion as to the real nature of this outer connection.

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[1] Archiv. f. Mik. Anat., V, 47.

[2] The Cell, p. 43. Macmillan Co.. N. Y.

[3] Archiv. f. Mik. Anat., 49.

Some observations upon living eggs of Lamellibranchs seem, however, to strengthen the position assumed by Hammar and to make it probable that the intercellular connection observed by him is, in some cases at least, really a living ectoplasma.

It is well-known that eggs frequently present a clear outer protoplasm that forms a true ectosarc over the more granular, yolk bearing interior part. In the eggs of the Lamellibranch, *Nucula delphinodonta*, this is very marked. Here the ectosarc rises up into waves and also into blunt pseudopodia-like papillæ, as seen under oc. 8. obj. 4 mm. These waves and processes change shape in such a way as to leave no doubt of the living nature of this ectosarc. In one case the ectosarc extended all over the polar body, so that it was included as a bubble might be escaping through a film of jelly, and a clear stalk or base of ectosarc was left between the egg and the polar body. But as these eggs were probably never fertilized and did not develop, the above phenomena may well have been abnormal.

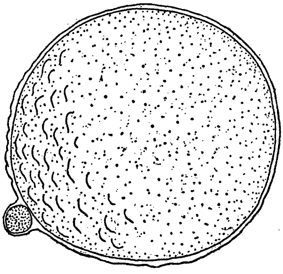

FIG. 1.

Yet in another Lamellibranch, *Angulus tener*, much the same was seen: figure 1, drawn from camera sketches of the living egg with oc. 4, obj. 2 mm., indicates the ectosarcal waves and a polar body buried in the ectosarc that surrounds it. In the two-cell stage marked ectosarcal waves rise up like frills on each side of the cleavage plane. When these cells divide to make four, the ectosarc is seen to follow the groove as it sinks down, figure 2, and not to leave the surface as Hammar described in Echinus. When the actual cleavage plane cuts

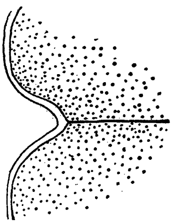

FIG. 2.

across the cell it does not affect the ectosarc which thus remains continuous from one cell to the other, figure 2. When the four cells formed flatten out against one another, figure 3, the ectosarc is continuous all over the egg, and not cut by the cleavage planes. That this is still a living ectosarc seems to be shown by the waves that rise up in it, especially over the smaller cells where they may be very high and sharp.

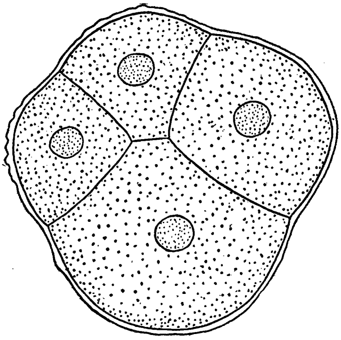

FIG. 3.

Similar waves were seen in the one cell stages of Yoldia, and may be common enough in Lamellibranchs. Thus Professor Brooks, in 1880,[4] called attention to contraction waves in the egg of the oyster. His figures indicate a clear outer layer continuous over all the cells in various stages of cleavage, and, apparently, continuous with the polar bodies which adhere together and to this layer up to a late stage of cleavage, *and in spite of the fact that a membrane is thrown off early in the cleavage.* It would seem necessary to interpret this layer as a living, membrane-forming substance, though with the low powers used, the wavy appearance figured was interpreted as being a wrinkling produced by contractions "which travel rapidly toward the formative pole, near which they disappear" (p. 42). These wrinkles vanished in about fifteen seconds, but came again upon other cells later in cleavage. It seems probable that further study will show that such waves are largely due to contractions in the ectosarc itself, as they seem to be in the cases I have examined with higher powers.

The connection between such ectosarcal portions of the Lamellibranch egg and the ectoplasmic layer of the Echinoderm egg is indicated by the appearance seen in figure 4. This represents a surface view of the opening into the cleavage cavity of a four-cell stage of the Echnius common at Roscoff, France, and was drawn from a *preserved* egg with camera lucida, oc. 18 and obj. 2 mm. A thin film of broken vesicular appearance stretches across the cleavage pore from one cell to the other, and is continuous with the surfaces of the cells, except where they arch down between the cells and on the sides of the cleavage pore. This film is absent, or broken, over part of the cleavage pore and beneath it are certain linear structures to be mentioned later.

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[4] Development of the American Oyster. Report of the Commissioners of Fisheries of Maryland, 1880.

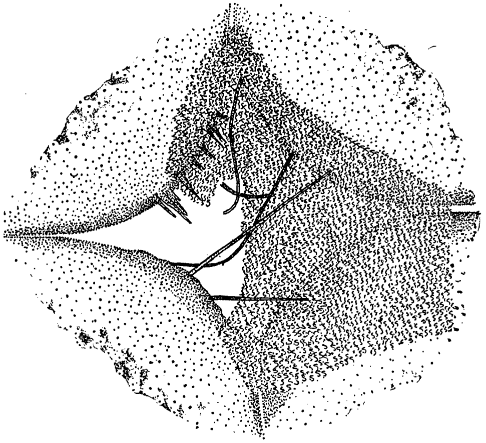

FIG. 4.

The peculiar official appearance of the layer makes it highly probable that it was a living ectosarcal substance extending from one cell to others. As such it seems the same as the continuous ectosarc of the Lamellibranch. It would appear to be the same thing seen by Hammar in Echinoderms both in section and in surface view—" In der Interstitien der Zellen kann man unter günstigen Umständen das abgehobene Ectoplasma auch im Flächenbild zum Gesichte bekommen" (1, p. 16).

We would conclude that the *living*, *ectosarcal*, membrane-like connection between the outer parts of cleavage cells actually exists in some eggs, whether in all the cases claimed by Hammar is still in doubt.

Another form of intercellular connection has been described by G. F. Andrews[5] in the cleaving eggs and larvæ of sea urchins and star fish; namely, fine filaments of living substance that are spun out from one cell to another much as a filose Rhizopod might connect with another by means of its delicate pseudopodia.

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[5] Some Spinning Activities of Protoplasm. Journal of Morphology. Vol. XII, 1897.

Figure 4 indicates the difference between the two modes of intercellular connection as seen in *preserved* material, where, however, the threads are fewer, thicker and otherwise altered by the Killing fluid and by subsequent treatment. Beneath the outer film of connecting substance and on various levels, (some quite far down), very definite protoplasm-like threads extend out from a cell and crossing the cleavage cavity become continuous with the surface of some other cell. These filaments have a characteristic shape, mode of origin, insertion, structure and size. They are the altered remnants and representatives of the living filaments seen in the live egg. Besides the long filaments the specimen shows pseudopodia-like processes or tufts of threads, arising from one of the four cells. These came upward toward the membrane-like expanse and seemed to be continuous with it, so that the filamentous substance and the filmy expanse appeared to have been one common material.

In life the filaments are subject to flow and to change, and the same *may* be true of the ectosarcal expanse.

Though the filamentous and the membranous connections of cleaving cells seem so different, it is not improbable that they are both expressions of the same contractile powers in the ectosarcal part of the egg cell, and they both serve to make the living material continuous from one cell to another.

In the living eggs of representatives of widely separated groups of animals we thus see reasons for believing that the process of cleavage does not isolate the cells as much as has been thought; either the cells remain connected from the first and are but areas in a common mass of living material, or they may make and break connection with one another by living filaments, formed as fast as cleavage tends to organize the egg into cell areas. In preserved material we see remnants of such connections, and it becomes probable that such connections will be found throughout the animal series.

With the ever increasing knowledge of intercellular bridges in animals and in plants, and the recently demonstrated fact that in Echinoderms these bridges are used as means of transportation, that the filaments allow material to pass from one cell to another, being, like Gromri's pseudopodia, *unstable sensitive, conductive, contractile,* we are on the road to admit not only the existence of such statical ectosarcal connections as Hammar discovers, but to accept as working hypothesis a conception of these bridges as dynamical factors of the greatest importance.[1]

A NORTH AMERICAN FRESH WATER JELLY FISH.

By Edward Potts.

On June 10, 1880, the first known fresh water jelly fish (*Limnocodium sowerbii,* Allman & Lankester) was discovered in the Victoria Regia tanks in Regent's Park, London. Near the end of November, 1884, a primitive "hydriform organism" from which it was supposed the jelly fish might have been derived, was found in the same tanks and described by Alfred Gibbs Bourne.[2]

About two months after Mr. Bourne's discovery, I first detected *Microhydra ryderi* upon some stones collected the previous autumn from the rocky bed of Tacony Creek, a rapidly flowing mill stream near Philadelphia, Pennsylvania, a small affluent of the river Delaware, but far above tide level. Some peculiarities in its structure and mode of gemmiparous multiplication were described by my valued friend the late Dr. John A. Ryder.[3]

Dr. Ryder had not, at the time of writing the above paper, seen the living organism which he there described. Specimens were, however, some years later, placed in his hands for study and watched for many months with exceeding interest. His early death has left in the possession of his representatives many excellent drawings and some valuable micro-slides as the only evidences of his interest and labor. No descriptive

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[1] The Living Substance. G. F. Andrews. Boston: Ginn & Co., 1897.

[2] Proceedings of the Royal Society, Dec. 11, 1884, Vol. 38, p. 9, etc. See also paper by F. A. Parson, Jour. of Queckett Club, 2nd series, vol. 2, 1885–6.

[3] American Naturalist, Extr , Dec., 1886, p. 1232, etc.